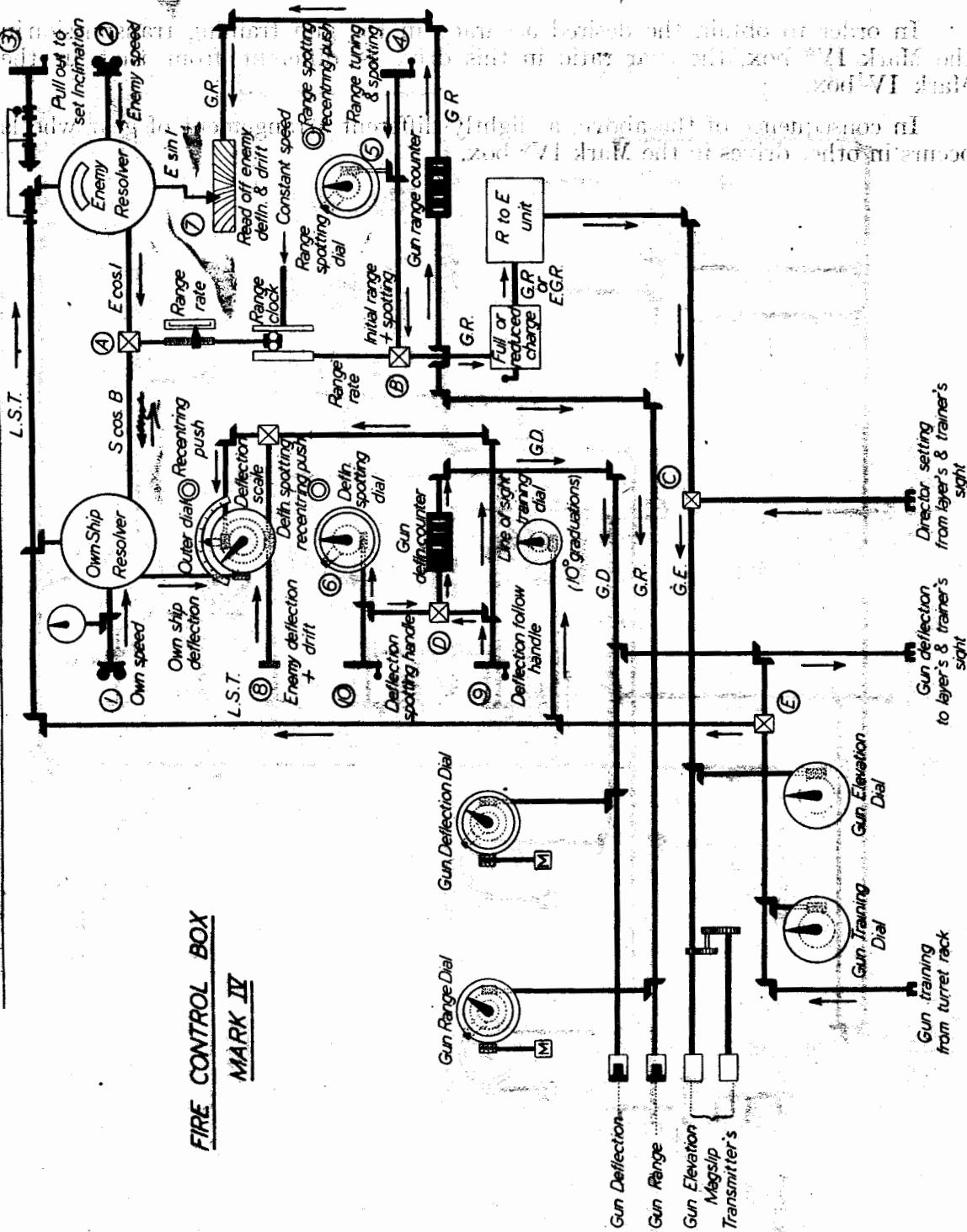


FIRE CONTROL BOX
MARK IV



CHAPTER I

THE OPERATION OF THE FIRE CONTROL BOX, MARK IV AND IV*

(See diagram on opposite page)

ACTION OF OWN SHIP RESOLVER

2. Own speed is set on own ship resolver by thumbscrew (1) and shows on the scale provided.

Line of sight training is fed mechanically into own ship resolver from a drive from the turret training rack through differential E. Gun deflection is removed from gun training in this differential to produce line of sight training.

This resolver produces own speed along the line of fire ($S \cos B$) and own ship deflection ($S \sin B \times \text{constant}$).

ACTION OF ENEMY RESOLVER

3. **Target speed** is set on the enemy resolver by thumbscrew (2) and shows through an aperture in the target ship, on the scale provided.

Inclination is set on the enemy resolver by handle (3), the model ship in the enemy dial showing the inclination against a circumferential scale. In order that inclination may automatically be kept up to date, for change in relative bearing, line of sight training is fed into the enemy resolver through a clutch. When setting inclination the handle is pulled out, temporarily disconnecting this clutch from the line of sight training drive and connecting it to the inclination handle.

(When own ship alters course it is necessary to pull out this handle.)

The enemy resolver produces target speed along the line of fire ($E \cos I$) and target speed across the line of fire ($E \sin I$).

THE PRODUCTION OF GUN ELEVATION

4. Own and enemy speeds along the line of fire combine in lattice differential (A) to give rate of change of range which shows on a scale, and positions the ball carriage in the range rate clock. The generated rate of change of range enters differential (B).

5. The fire control box is tuned by pressing in and turning handle (4). This range (which shows on the gun range counters and the black pointer in the gun range dial) meets change of range in differential (B) to form clock range. The spotting pointer is not moved if the range handle is turned in the IN position.

Note.—No range corrections are calculated in the fire control box, hence gun range is the same as clock range.

6. **Range spotting corrections** are applied by turning handle (4) in the out position, and are shown on the dial (5). This dial is fitted with a total spotting corrections rim pointer and a "fly-back" pointer.

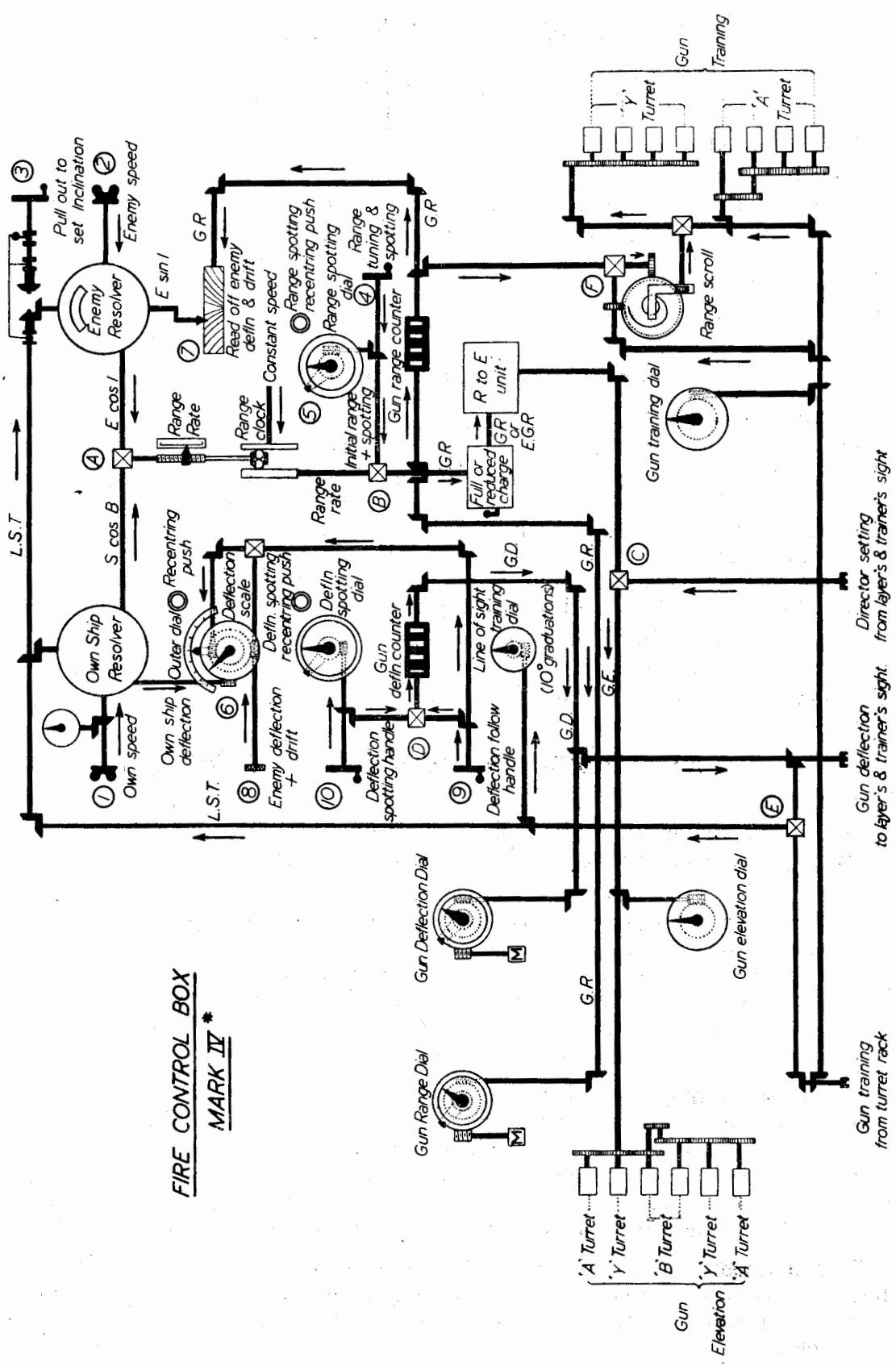
Note.—A strong spring is provided to keep the handle in the out position except when tuning, as otherwise the gun range counter and black pointer in the gun range dial will be moved without any correction showing on the spotting dial.

7. **Gun range** passes through a full charge to reduced charge reduction gear (which for reduced charge purposes transforms gun range into equivalent full charge range) and into the range to elevation unit, where it is converted into tangent elevation.

Note.—In the Mark IV box, gun range is transmitted electrically by "M" type transmitter to a receiver in the O.O.T.'s position.

8. The corresponding tangent elevation meets director setting in differential (C) to form **gun elevation**, which is shown by the mechanical pointer of the gun elevation repeat dial and transmitted to the guns by magslip transmitters.

FIRE CONTROL BOX
MARK IV *



PRODUCTION OF GUN DEFLECTION

9. Deflection due to own speed across the line of fire ($S \sin B \times \text{constant}$) rotates the own deflection dial (6) and is applied by turning the follow handle until the black inner pointer is in line with zero on this dial.

10. Enemy speed across the line of fire ($E \sin I$) positions a pointer on drum (7). This drum is rotated for gun range and is graduated to show **enemy deflection plus drift**.

Enemy deflection plus drift is read off the drum and is set by turning the knob (8) so that the yellow pointer on the outer dial shows the required setting. The black inner pointer is moved simultaneously but in the opposite direction.

Enemy deflection plus drift is applied by turning the follow handle (9) until the black inner pointer is returned to zero on the inner dial. Change in enemy deflection can be rejected by pressing the recentring push.

11. **Deflection spotting corrections** are applied by the deflection spotting handle (10) moving the inner pointer of the deflection spotting dial, their sum, right or left, being shown by the blue rim pointer. The inner pointer is a "fly-back" pointer.

12. Total calculated deflection (from the deflection follow handle) and deflection spotting meet in differential D, show on the gun deflection counters and on the black pointer of the gun deflection dial, and by the out-going drive, offset the layers and trainers sights. A drive also passes into differential (E) where it is subtracted from gun training (see paragraph 2).

Note.—In the Mark IV box, deflection is transmitted electrically by "M" type transmitter to a receiver in the O.O.T.'s position.

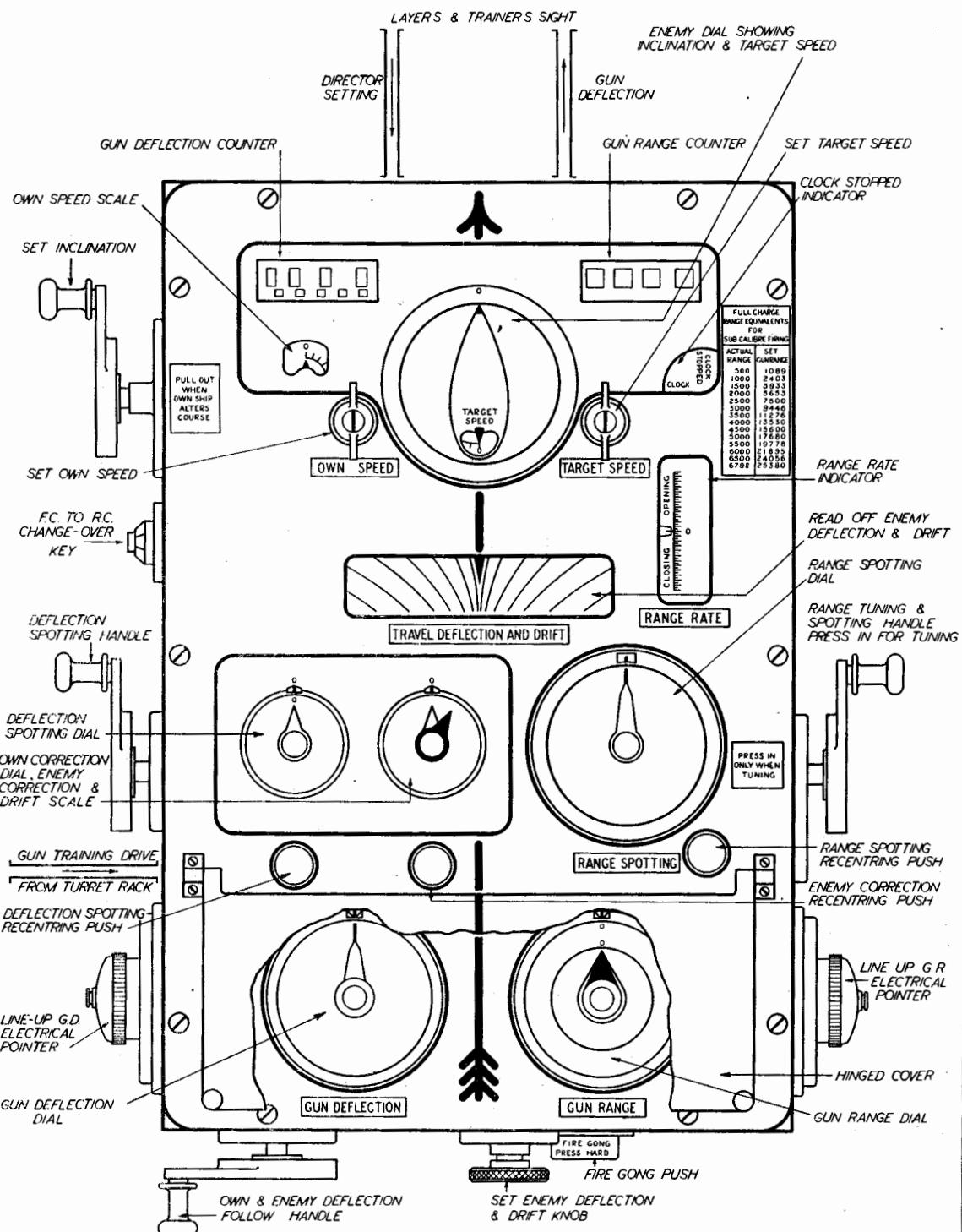
THE FIRE CONTROL BOX, MARK IV*

(See diagram on opposite page)

13. The action of the resolving gear and the production of **gun elevation** is the same as in the fire control box, Mark IV. Additional gun elevation transmitters are fitted for transmission of gun elevation to "A" and "Y" turrets. No allowance is made for dip. There is no gun range transmitter.

14. **Gun training** is transmitted electrically to "A" and "Y" turrets, the transmitters to "A" turret being driven direct from the gun training drive from the turret rack. This drive passes to differential (G) where convergence is added, and then passes on to "Y" turret transmitters. There is no gun deflection transmitter.

15. **Convergence correction** for the distance between "B" and "Y" turrets is produced in the convergence mechanism. A drive from gun training keeps the mechanism set for bearing, the correction being modified for range by a drive from the gun range counters. This drive passes through differential F and operates one disc of the convergence gear; gun training passing through this differential causes both discs to revolve together.



THE TOP OF THE FIRE CONTROL BOX

*MARK IV & IV**

CHAPTER II

DRILL AND PROCEDURE AT THE F.C.B., MARKS IV AND IV*

(*The diagram on the opposite page shows the top of the instrument*)

23. Near the top is seen the target ship model whose inclination is set by the handwheel on the left. Through a window in the target ship is visible the target speed dial. To right and left are the thumbscrews for setting target speed and own speed, the latter on a dial seen through a window close to this thumbscrew. Above the target ship are the gun range and gun deflection counters.

24. Short of the target ship, and seen through another window, is the drum on which is read deflection due to target speed across combined with a correction for drift at the range in use. To the right of the drum is a scale on which a pointer indicates the range rate calculated in the instrument. Above and to the right of the range rate scale is a scale of equivalent full charge ranges for use in sub-calibre firing.

25. Nearer to the observer are the deflection spotting dial and handle, deflection follow-up dial for applying own deflection and that due to enemy and drift, knob for setting enemy and drift deflection and the deflection follow handle. On the right are the range spotting dial, and the range tuning and spotting handle.

26. Near the lower end are the gun range and gun deflection dials. The red pointers of these dials show gun range and deflection as transmitted from the T.S. and the dials correspond in use to the range and deflection dials of local director sights in other ships for use in gunlayers' or quarters firing when the T.S. is still in action.

27. A flap is fitted between the deflection spotting and follow-up dials and the gun range and gun deflection dials which covers up the deflection spotting and follow-up dials when in main control, or covers up the gun range and gun deflection dials when in local control. On the front of the box is the fire gong push.

PART I.—F.C.B., MARK IV

DUTIES OF THE CREW

28. The F.C.B. can be worked by two men.

No. 1 . . Communication with the Control Officer. Range tuning and spotting operator. Operates the fire gong.

No. 2 . . Deflection and inclination operator.

Note.—A third man, normally the telephone operator to the T.S. may be used as the inclination operator in local control.

ON CLOSING UP

29. Immediately on closing up, break the lining up switches, put the local control change-over switches (two in number) to local control and close all switches on the L.P. board.

30. **At the F.C.B.**—(a) Line up the gun range red pointer to the lining up range and the gun deflection red pointer to zero.

(b) Set own and enemy speeds to zero.

(c) Set deflection to zero as follows:—

Centre yellow pointer by enemy setting knob.

Centre total spotting pointer (blue) by spotting handle.

Centre black spotting pointer by recentring push.

Set deflection counter to zero by deflection follow handle.

Centre black pointer of own and enemy dial by recentring push.

(d) Set range to lining up position as follows :—

Centre total spotting pointer (red) by range handle in out position.

Centre spotting pointer (black) by recentring push.

Press in on range handle and tune gun range counter to lining-up range.

(e) Set charge change clutch to full or reduced charge as ordered.

31. **At the local director sight.**—Lay the local turret sight so that the lining up elevation shows on the gun elevation repeat dial on F.C.B. The gun training repeat dial should show zero if the turret is locked.

32. Set the range transmitter of the turret rangefinder to the lining up range and line up the repeat receiver at the F.C.B.

33. **At the O.O.T.'s position.**—Line up the combined range and deflection receiver to the lining up range and zero deflection.

SWITCHING ON LOW POWER

34. When all instruments are lined up, close the lining up switches.

CHECKING LOCAL CONTROL CIRCUITS

35. Officer of turret orders a range, deflection and elevation. This range and deflection are set on the range and deflection counters by the range tuning and deflection spotting handles. The local sight is laid so that the elevation ordered is shown on the gun elevation repeat dial. The range transmitter of the turret rangefinder is set to the range ordered.

No. 1 rings the fire gong and the gun interceptors are closed.

36. Officer of turret orders "**Check receivers.**"

Gun elevation receivers are read off and reported to the local control cabinet. O.O.T. checks the combined range and deflection receiver.

No. 1 checks the range receiver from the turret rangefinder, and that the gun ready lamps are burning. If receivers are correct the officers of turret orders "Open interceptors." If time permits, local firing circuits are tested before putting the switches back to main control.

Telephone operator now reports to T.S. " — **Turret lined up.**"

Main control instruments and director firing circuits may then be tested.

37. The procedure detailed above caters for the lining up and checking of the F.C.B., Mark IV, and instruments fitted in its own turret. At what stage it is undertaken must depend on the procedure in use for the lining up of the main armament as a whole, for it must be remembered that when switches are to local control, the majority of the receivers are cut off from the T.S., thereby interfering with any checking of receivers, etc., on the part of the T.S.

38. With regard to the F.C.B., Mark IV*, the checking of the transmissions of gun elevation and gun training to "A" and "Y" turrets and the fire gong, gun ready lamp and firing circuits to "A" and "Y" turrets must also be carried out. When checking gun training, the receivers should be compared with the gun training dial on the F.C.B. or "B" turret training receiver from which "Y" turret training will differ by the amount of convergence applied. To avoid confusion, the checking of "**B turret controlling**" should await orders from the T.S.

DRILL AT THE CLOCK

I.—IN MAIN CONTROL

39. The latest information from the A.F.C.T. is always to be kept set on the F.C.B.

When engaging a target in main control, No. 1 puts the flap cover over the deflection dials and keeps the black pointer of the gun range dial in line with the red by turning the range tuning handle in its "IN" position. No. 2 sets own and enemy speed and inclination from information received from the T.S. or O.O.T. and keeps the black pointer of the gun deflection dial in line with the red by the deflection spotting handle.

II.—IN QUARTERS FIRING

40. The turret may be layed, trained and fired, using the local sighting and firing arrangements while being controlled from another position, the T.S. continuing to transmit control information.

The operation of the F.C.B. is as described in paragraph 39.

III.—IN LOCAL CONTROL. (a) SAME TARGET

41. On receiving the order "**local control**," the change-over switches are put to "LOCAL" by the telephone operator, who then becomes No. 3 inclination operator.

No. 1 puts the flap cover over the gun range and gun deflection dials, pulls out the range tuning handle and allows the rate to take charge.

No. 2 sets the yellow pointer of own and enemy deflection dial to the deflection shown on the drum by means of the enemy deflection knob. He then recentres both deflection black pointers by the recentring pushes and reports "**Deflection set**."

Note.—(a) No change is made in total gun deflection, as neither the enemy follow up nor deflection spotting handles have been moved.

(b) If no enemy settings have been received from the T.S., these must be ordered by the Control Officer and set, but the enemy follow-up handle should not be moved, the black pointer being recentred by the recentring push, No. 2 reporting "**Deflection set**" as above.

42. Control Officer orders "**Shoot**." No. 1 presses the fire gong and orders "**Fire**" to the local sight layer.

Nos. 1 and 2 apply range and deflection spotting corrections as ordered by the Control Officer.

No. 3 sets enemy speed and inclination as ordered by Control Officer.

No. 2 watches the enemy deflection and drift drum and keeps the yellow pointer of the deflection dial set against the outer scale, applying any changes by realigning the black pointer with the red zero by using the follow handle. By keeping the black pointer continually in line with the red zero he also applies any change in own deflection.

Procedure if enemy is seen to alter course

43. The Control Officer orders "**Enemy altering course**" and forecasts the inclination.

44. When the enemy is steady, the Control Officer orders "**Enemy steady**."

No. 3 sets the inclination as ordered, pressing in the handle after each setting.

No. 2 sets the yellow pointer of the deflection dial to the enemy deflection and drift as shown on the drum and applies the change by realigning the black pointer with the red zero.

Procedure when enemy alters course but is not observed

45. If the target is "lost," it will indicate to the control that the enemy has made an unobserved alteration of course or speed or both. The target will be regained by spotting and the Control Officer will order new inclination or speed settings.

46. Since the target has been regained by spotting, it is not desired to apply any further change to deflection. If, therefore, an order for a new inclination is received without the report "Enemy altering course," No. 3 orders "**Not apply.**"

No. 3 sets the new inclination as before.

No. 2 sets the yellow pointer of the deflection dial to the enemy deflection and drift shown, and realigns the black pointer with the red zero by the recentring push. The yellow pointer still shows the up-to-date reading of the enemy deflection and drift drum but the change of deflection caused by the new settings has not been applied to the deflection.

Procedure when own ship alters course

47. If possible, all alterations of course of own ship should be reported to the turret, and also when own ship is steady.

48. The turret trainer can tell when own ship alters course by the change in rate of training and should report "**Own ship altering course**" to the F.C.B. and should also report when he considers own ship has steadied on the new course.

49. On receipt of the report "**Own ship altering course**":—

No. 3 pulls out the inclination handle. The change of bearing caused by own ship altering course does not then alter the inclination.

No. 2 applies the change in own ship's deflection by keeping the black pointer of the deflection dial aligned with the red zero, by using the follow handle.

50. When the report of own ship "**Steady**" is received, No. 3 pushes in the inclination handle, thus again clutching in the bearing drive to the inclination dial.

Note.—This procedure must be carried out when in main control, so that enemy inclination is always kept correctly set.

IN LOCAL CONTROL. (b) NEW TARGET

51. The Control Officer will order "**Local control.**" The change-over switches are put to "**LOCAL**" by the telephone operator who then becomes No. 3 inclination operator.

No. 1 puts the flap cover over the gun range and gun deflection dials.

Control officer will order own ship's speed and visibility range.

No. 2 will set own ship's speed, No. 1 will set the range ordered on the gun range counters by the range tuning handle.

52. When a target is sighted, Control Officer will order "**Enemy in Sight—Load,**" and will give a rough bearing and range and will con the turret on. He will order the speed and inclination of the enemy.

When the turret local sight layer and trainer are on the target, they will report "**Target.**"

53. No. 1 presses in on the range handle and sets the range ordered, reporting "**Clock tuned**" to the Control Officer. When ranges are obtained by the turret rangefinder, No. 1 will keep the range tuned to the mean of the ranges shown on the range receiver from the rangefinder pulling out on the range tuning handle after each setting to allow rate to take charge.

No. 3 sets the enemy speed, pulls out handle to set inclination and then pushes inclination handle in.

No. 2 (a) Reads off the enemy deflection and drift from the drum and turns the enemy setting knob until the yellow pointer shows the enemy deflection and drift against the outer scale.

(b) Operates the follow handle to realign the black pointer of the deflection dial with the red zero, thus applying the deflection for own ship movement, and for enemy and drift.

(c) Reports "**deflection set.**"

The Control Officer may order a deflection spotting correction for wind, e.g., "**Wind—left six**"; No. 2 applies this as a spotting correction by the deflection spotting handle, subsequently recentring the black spotting pointer by the recentring push and reporting "**Wind set.**"

OPENING FIRE PROCEDURE

54. On receiving the reports "**Deflection set**" and "**Wind set**" the Control Officer orders "**Right . . .**" (so as to apply the first step of the initial deflection group) and orders "**Salvos.**"

No. 2 applies the deflection correction on the spotting dial, and applies all subsequent line spotting corrections ordered by the control officer.

Control Officer reports to the Captain "**Ready to open fire**" and on receiving the order to open fire, orders a range spotting correction based on the rate (so as to apply range correction for time of flight) and "**Shoot.**"

No. 1 applies the range correction on the spotting dial and applies all subsequent range spotting corrections ordered by the control officer; ceases tuning to range-finder and allows the rate to take charge. Then orders "**Fire**" and presses the fire gong.

55. No. 2 watches the enemy deflection and drift drum and keeps the yellow pointer of the deflection dial set against the outer scale, applying any changes by realigning the black pointer with the red zero by using the follow handle. By keeping the black pointer continually in line with the red zero he also applies any change in own deflection.

Procedure if own or enemy ship alters course

56. This procedure is as detailed in paragraphs 43–50.

REDUCED CHARGE AND SUB-CALIBRE FIRINGS

57. The drill for reduced charge firing is the same as that described above. The charge change clutch is put to reduced charge, this generates the correct tangent elevation for the range in use and also exposes the reduced charge curves on the enemy and drift drum thus giving the correct deflection. The deflection required for own ship's movement is the same as in full calibre. For sub-calibre firing, the charge change clutch is put to full charge and the scale of equivalent full charge ranges on the top of the box is used. The errors in deflection and range spotting must be accepted.

THROW-OFF FIRINGS

58. The F.C.B., Marks IV or IV*, cannot be used in throw-off firings.

FAILURE OF MAIN DRIVE

59. If the main drive breaks down, No. 3 leaves the inclination setting and operates the hand drive. No. 2 then sets enemy speed and inclination in addition to his normal duties.

CONTROL PROCEDURE AT NIGHT

60. Drill at the F.C.B. is the same as for day, except that fire may be opened with only own ship deflection set. If time permits enemy speed and inclination may be ordered so that a more accurate deflection is produced and rate is applied.

61. Fixed sight procedure is not carried out.

62-64.

PART II.—F.C.B., MARK IV*

65. The drill and procedure are the same as those given for the F.C.B., Mark IV, with the following exceptions.

66. Reference paragraph 28. *Note.*—The telephone operator will be required for communication with "A" and "Y" turrets when "B" turret is controlling.

Reference paragraph 36. There is no range or deflection receiver in the Control Officer's position.

Reference paragraph 59. The F.C.B., Mark IV*, may be used in the event of a breakdown in the main director circuits, when "B" turret is used as a director, transmitting gun elevation and training to the other two turrets in addition to gun elevation to its own guns. The F.C.B. is kept set to the range and deflection transmitted from the T.S. "B" turret local layer fires all guns from his local sight pistol.

67. When "B" turret is controlling the other turrets, the drill and procedure are the same as those given for the F.C.B., Mark IV, in local control.

68-69.

CHAPTER III

THE MECHANISM OF THE FIRE CONTROL BOX, MARKS IV AND IV*

OWN SPEED AND TARGET SPEED RESOLVING MECHANISM

Plate 1

70. This unit contains the four discs of the resolving mechanism and their cross-slides and linkages, the two lower discs constituting the own ship resolver, the two upper the enemy resolver.

71. **Own speed** is set by pressing down and turning the pink thumbscrew. Below this thumbscrew are two spring clutches (A) and (B) of which (A) is normally held open by its spring and (B) is held closed, locking the three pink wheels.

Downward pressure engages clutch (A) and disengages clutch (B). Rotation sets the dial, and through wheel (B) and the pink train rotates the pink hub of the differential. The blue hub being considered stationary the movement of the pink hub is transferred through the mauve cage, to the mauve cam disc of the own ship resolver which is thus rotated to a setting of own speed.

In this disc is a cam groove cut spirally which when rotated for one knot settings on the dial gives equal increments of movement of the roller in the cam groove from the centre of the disc.

Attached to the roller is a mauve block free to slide radially in a slot between guides in the pale blue concentric disc, its distance from the centre of the pale blue disc being determined by the rotation of the mauve disc.

72. **Target speed** is set by pressing down and turning the red thumbscrew. Below this thumbscrew is spring clutch (C), normally held open by its spring, and a spindle upon the lower end of which are two pinions rigidly mounted upon their spindle which, however, is free to turn because clutch (C) is open. The two pinions are engaged by the red and the pale blue discs.

Downward pressure engages clutch (C) and disengages the lower red pinion from the pale blue disc while leaving the upper pinion (which is relatively wide) still in mesh with the red disc. Rotation therefore sets the disc to a measure of target speed, read through an aperture in the target model, the scale being in the form of a dial connected to the red disc. On the underside of the red disc is cut a cam groove similar to that in the mauve disc, and in the groove travels a roller attached to the red block which is free to slide radially in a slot between guides in the pale blue concentric disc below it.

73. **Inclination** of the target's course relative to the line of fire is set by pulling out and turning the target inclination handle, pale yellow. This action engages the splined green clutch with the pale yellow wheel which is turned by the pinion on the handle shaft. The drive from the target inclination handle then turns the pale blue horizontal shaft which thus sets the pale blue disc of the enemy resolver to inclination. The dial on which the target is engraved is carried by this disc, and the inclination is read relative to an engraved dial whose zero is the line of fire.

Rotation of the pale blue disc is accompanied by an equal rotation of the red cam disc in the same direction since both are in mesh with the rigidly mounted red pinions below the target speed setting thumbscrew, and this duplex pinion is free to rotate. After setting, the inclination handle is pushed in.

74. **Line of sight training** which is shown (for lining up purposes during erection) by the dial in the lower left-hand part of this plate, enters from Plate 7 or Plate 7* by the pale blue coupling. Line of sight training then passes through the pale blue train and pale blue hub and mauve cage of the differential and, the pink hub being held by clutch (B), rotates together the mauve and pale blue discs, of the own ship resolver.

In order also that inclination of the target may automatically be kept corrected for change in relative bearing, the splined green clutch being in the position shown in this plate, any change in line of sight training, by the upward pale blue drive, and horizontal shaft rotates the two discs of the enemy resolver, as above described.

So that alterations of course of own ship, however, with consequent changes of line of sight training may not affect the inclination set on the inclination dial, it is necessary while altering course to pull out the target inclination handle and to push it in again when "steady." For this purpose the inclination operator must be informed when own ship alters course and when own ship is "steady."

75. In the own ship resolver the distance of the mauve sliding block from the centre, combined with rotation of the pale blue disc, determines the position of the vertical mauve spindle and hence of the yellow link for "**Own speed along line of fire**" and of the red link "**Own speed across line of fire.**" The movement of the red link produces a movement on the red rack which gives deflection due to own speed across.

The red rack is engaged with a pinion which gives a rotary movement to mechanism in Plate 6.

76. Similarly in the enemy resolver the distance of the red sliding block from the centre combined with rotation of the pale blue disc determines the position of the yellow link and of the blue link, producing enemy speed along the line of fire and enemy speed across the line of fire. The latter is transmitted by the blue lattice, one end of which is pivoted on the fixed structure, to the blue pointer by which it is read off the enemy deflection drum in Plate 4.

Rate of change of range

77. The movement of each of the yellow links representing "**Own speed along the line of fire**" and "**Target speed along the line of fire**" is added by the differential lattice, yellow, the position of whose centre gives a measure of the rate of change of range and its direction opening or closing. Through the bush in the centre of the lattice passes the pin on the ball carriage yellow, in Plate 2.

78. Also shown in Plate 1 are the gun range and gun deflection counters operated by mechanism in Plates 3 and 6 respectively, and the clock-stopped indicator from the constant speed motor in Plate 2.

Operation of the splined green clutch

79. The two arms acting as one lever are pivoted on the fixed structure. Their right-hand ends are actuated by a rocker engaged by the inclination handle shaft in such a way that pulling out the inclination handle disengages the green clutch from the pale blue pinion and engages it with the pale yellow wheel driven by the pinion on the inclination handle shaft. The object of the spring between the arms is to facilitate engagement of the teeth on the clutch face should it happen that the teeth are not in line when the change is made.

Note 1.—The two red pinions below the target speed setting thumbscrew are rigidly connected to the spindle. The width of the lower pinion is less than that of the upper pinion so that when the thumbscrew is pressed down the lower red pinion disengages from the pale blue disc but the upper red pinion remains in mesh with the red disc. The teeth of the lower red pinion are radiused to facilitate re-engagement with the pale blue disc when pressure is removed from the thumbscrew.

Note 2.—The pink pinion at (B) is also relatively wide so that when the own speed setting thumbscrew is pressed down, disengaging the clutch (B), this pinion remains in mesh with the pink drive to the pink hub of the differential.

Note 3.—In the Mark IV* box the gearing in the line of sight training drive (pale blue) is different from that shown in Plate 1. The actual differences in this drive can be seen from Plate 12, Gearing Diagram.

MAIN DRIVE MOTOR AND GEARING, ALTERNATIVE HAND DRIVE AND THE VARIABLE SPEED GEAR

Plate 2

86. **Rate of change of range** calculated by the own ship and enemy resolvers in Plate 1, and added by the differential lattice, is transmitted from the mid-point of the lattice to the pin with which it engages, on the yellow carriage in this plate.

This is the ball carriage of the variable speed mechanism whose position determines the direction and speed of the generated rate of change of range, and to it is attached a pointer, yellow, reading against a range rate scale.

87. The disc, orange, of the variable speed gear is driven at a constant speed by the motor in the lower part of the plate, through the orange train, which includes the drive to a stop-watch by which its speed can be checked, and to the "Clock-stopped" indicator in Plate 1.

88. **Generated rate of change of range** is transmitted by the balls in the ball carriage to the blue roller and thence through reducing gears and the blue couplings out to Plate 3.

The cam shaft, green, driven to gun range by other mechanism in Plate 4 lifts the blue generating roller off the topmost ball at the upper and lower limits of range.

89. An alternative hand drive is provided for use in the event of failure of the power drive. To drive by hand the handle is pushed in and turned at a speed which keeps the hand of the stop-watch underneath the cursor. The irreversible clutch allows the hand drive to operate without revolving the motor.

Note.—The motor is fitted with a speed regulating device and is controlled by a switch on the front of the pedestal of the fire control box.

90-110.

RANGE TUNING AND SPOTTING MECHANISM

Plate 3

111. The fire control box is tuned to the initial range by pressing in and turning the handle, pale blue, shown on the right of this plate.

This drives through the pale blue train to the pale blue cage of the differential. Wheels A, B, C, D are out of mesh and wheels E and F are in mesh when the handle is pushed in.

112. **Generated rate of change of range** from Plate 2 enters by the dark blue drive and revolves the left-hand hub of the differential. Assuming the pale blue drive to be stationary, the differential through its green hub and the green train transmits the resultant gun range—

- (i) to the gun range counter in Plate 1;
- (ii) to other mechanism in Plate 4;
- (iii) via Plate 6 to other mechanism in Plate 7 or 7*;
- (iv) to the gun range dial in Plate 10.

113. **Range spotting corrections** are applied by turning the handle, pale blue, in the "OUT" position in which pinions A and B, C, D, are in mesh. The red drive then rotates the red pointer and the red rim pointer by an equal amount, and the same movement is applied to gun range through the pale blue train, the pale blue cage, and green hub of the differential.

114. The red pointer is a "fly-back" pointer which is reset to zero after a spotting correction has been made; the red rim pointer, travelling round the dial which is graduated to 2,000 yards "up" and "down," shows the sum of all spotting corrections that have been applied.

115. The ratchet stop gear shown in the pale blue drive is operated at the high and low limits of range by mechanism in Plate 4.